Eur J Health Econ (2008) 9:69–78
DOI 10.1007/s10198-007-0041-x

ORIGINAL PAPER

Willingness to pay for a reduction in mortality risk after a myocardial infarction: an application of the contingent valuation method to the case of eplerenone

Jose-Luis Pinto-Prades · Veronica Farreras · Jaime Fernandez de Bobadilla

Received: 13 June 2006 / Accepted: 17 January 2007 / Published online: 20 April 2007

Abstract In order to allocate health care resources more efficiently, it is necessary to relate health improvements provided by new medicines to their cost. It is necessary to ascertain when the additional cost of introducing a new health technology is justified by the additional health gain produced. Eplerenone is a new medicine that reduces the risk of death after myocardial infarction (MI) but produces additional cost to the health system. The contingent valuation approach can be used to measure the monetary value of this risk reduction and to estimate society's willingness to pay (WTP) for a new medicine that reduces the risk of death after MI by 2% points. We used a contingent valuation approach to evaluate WTP amongst members of the general population. We used the ex-ante and the ex-post approach. In the ex-ante approach, subjects are asked if they would accept an increase in their taxes in order to have access to eplerenone should they need it in the future. In the ex-post approach, subjects are asked if they would pay a certain amount of money as co-payment per month during 5 years if they suffered an MI. We used the dichotomous choice method, using five bids in each approach. The WTP was estimated using both single-bound and double-bound dichotomous choice (SBDC, DBDC). Extensive piloting (n = 187) preceded the final survey (n = 350). The WTP in the ex-ante case was €58 per year under both SBDC and DBDC. In the ex-post case, monthly WTP was €141 for the SBDC and €85 for the DBDC. Subjects with higher income and subjects with a higher perception of risk showed a higher WTP ($P < 0.05$). Society is willing to pay an additional amount of money in order to give eplerenone to present and future patients. We estimate that €85 per month is a conservative estimate of the monetary value of a 2% risk reduction in mortality after MI and to spend this additional amount of money in Eplerenone can be considered an efficient policy.

Keywords Contingent valuation · Myocardial infarction · Mortality · Cost-benefit

J.-L. Pinto-Prades (✉)
Department of Economics,
Ctra. Utrera s/n, University Pablo de Olavide,
Sevilla 41089, Spain
e-mail: jlpinto@upo.es

V. Farreras
Forest Technology Center of Catalonia
and Department of Applied Economics,
Autonomous University of Barcelona,
Barcelona, Spain
e-mail: veronica.farreras@hotmail.com

J. F. de Bobadilla
Pfizer, Madrid, Spain
e-mail: jaime.fernandez@pfizer.com

Introduction

One of the most important questions for managers of health care systems is how to allocate scarce resources. This question is especially important in the case of new medical technologies (medicines, medical devices) that are more effective than the standard but more costly. A large part of the increase in health expenditures is due to these new technologies [1]. To have more effective medical technologies is something desirable from any perspective, however, this technological progress is putting health systems under financial stress [2]. Given budgetary restrictions, health care managers have to choose those technologies that give greater value for money.

Faced with these resource allocation problems, economists have elaborated a methodology generally known as economic evaluation (cost-effectiveness, cost-benefit analysis). Efficiency requires that benefits are maximised and opportunity costs minimised. In order to allocate resources in an efficient way, we need good measures of the costs and benefits of medical technologies. If a new procedure is less costly and at least as effective as the status quo, it would be judged to be better (more technically efficient). If a new procedure is more costly and more effective, a judgment has to be made about whether the extra cost is worth the gains achieved (a question of allocative efficiency since more resources would have to be allocated to this technology). Traditionally, this economic evaluation has moved between cost-effectiveness analysis (CEA) and cost-benefit analysis (CBA). CEA can deal with questions of technical efficiency but not of allocative efficiency. CBA can deal with both kinds of problems [3].

In spite of being a more powerful tool, CBA has been less used in the evaluation of medical technologies since it requires the valuation of health in monetary units. However, when we have to make decisions about medical technologies that request more funds, we face a decision that involves allocative efficiency and CBA is the appropriate tool [3]. In this paper, we want to respond to a question of allocative efficiency. We want to know how much a National Health Service (NHS) like the Spanish one should invest in order to fund a new medicine that is more effective than the status quo but also more costly.

Eplerenone [4] is a selective aldosterone blocker that reduces morbidity and mortality among patients with acute myocardial infarction (MI) complicated by left ventricular dysfunction and heart failure. It is therefore a medicine that increases the effectiveness of the treatment of MI. However, it requires an additional investment from the health service. The question is, then, up to what point is it sensible to invest more resources in order to increase the effectiveness of a treatment for MI? All health systems have to establish limits on what it is reasonable to spend in a medical treatment even if health effects are very important (reduction in mortality), as in this case.

Since eplerenone reduces mortality we need to estimate the monetary value that people attach to a reduction in the risk of death. In order to do so we use a technique known as contingent valuation (CV) [5]. This method has been mainly developed to value changes in goods that cannot be traded on a market such as cleaner air, noise reduction or preserving a recreational area. The CV has also been applied to assess changes in health [6]. In this paper, we will use the CV method in order to elicit the monetary value of eplerenone. The study is based on interviews with a sample of the general population in Spain.

Subjects and methods

Survey participants

Survey participants comprised 537 members of the Spanish general population. Initial telephone calls were made to a random sample of households based on random digit dialing. The persons were asked to participate in a survey. Those who agreed to participate were interviewed face-to-face at the subject's home in the second half of 2004. The strata followed the age and gender structure of the population. There is some debate in the literature about which is the correct population to provide their preferences in order to make resource allocation decisions in health care [7]. Most studies have been conducted asking patients about their WTP. However, there are theoretical arguments in favor of using members of the general population [8] as the relevant population. One reason is that when deciding whether a new treatment will be funded or not we should include the preferences of all subjects that can benefit from this program in the future. It has been argued that for CBA ''the relevant population is a sample of all persons who may benefit (or lose) by the introduction of the program within a defined jurisdiction'' [9]. In our case, the relevant population would then be the general population since all of them could use eplerenone in the future. Also, since the Spanish health system is funded out of taxes, it is the general population who pays for the NHS. This is another argument in favor of using members of the general population as participants in the survey.

The main argument most frequently quoted in favor of using patients as subjects is that they are in a better position to value a medicine that improves their health. This argument is less valid in our case since we are dealing with mortality risks, and this is a kind of outcome that can be easily understood by members of the general population. The use of patients as subjects in a WTP study also has very important problems related to fairness. In many instances, patients have a lower income than the general population, and it is the average income of a country that establishes the budgetary restrictions for the NHS, not the average income of patients. In our case, this is quite clear. As the average age of patients is 67, most of the users of eplerenone are retired people that have (presumably) a lower income than those who are in the active population. In general, since WTP is constrained by income, and since it is the average income of the general population that has to determine the limit that a society can spend on health, we think that members of the general population are the right sample to be consulted in WTP studies, at least if the objective of the study is to decide whether a technology has to be provided by the NHS or not.

The question

It has been suggested [8] that if we use the general population in a CV study, WTP questions have to be asked in an insurance context, that is, how much the respondents would be willing to pay in order to have access to a medical technology in case they need it. This is also known as an ex-ante perspective. Since the Spanish health system is basically funded out of taxes, the WTP ex-ante question has to be asked in terms of an increase in taxes [10]. Subjects were therefore asked if they would accept a permanent increase in taxes in order to have eplerenone available if they had an MI in the future. Although we believe this is a correct theoretical point, it requires the subject to work with complicated information, such as the probability of needing the medicine in the future and the probability of having a better health outcome if the medicine is needed. In our case, the participants were informed of their risk of suffering an MI in the future. This risk was different for different groups of subjects, according to age and gender. Effectiveness of the medication was assumed to be constant across all subjects. The question was framed as follows: ''Do you think that you would vote in favour of an increase in taxes of ... euros per year for the rest of your life, given that you have a probability of .....% of needing eplerenone in the future?'' The participants had been previously informed that eplerenone reduced the risk of death from 16 to 14% after an MI.

Given that the cognitive burden is quite heavy under this kind of framework, we also framed the question under conditions of certainty, that is, we asked about their WTP in case they were patients. This is the ex-post perspective. The question was framed as follows: ''Assume that you have had an MI. After you leave hospital you need to take medicines in order to prevent another MI. With the usual treatment, 16% of patients die the first year after the MI. There is a new treatment and the risk is reduced to 14%. However, the new treatment is more expensive and it would cost you ... € per month for 5 years''. It has been argued that this ex-post framework provides a conservative estimate of WTP for health gains [11].

Willingness to pay

There are several formats that can be used to ask WTP questions. Among these are ''open-ended'', ''bidding game'', ''payment card'' and dichotomous choice [12]. In the open-ended (OE) question, respondents are asked for their maximum WTP for something that they value. The bidding game offers a sequence of bids (certain amounts that people are asked to pay) to the respondent so that the maximum WTP can be elicited. Payment card is another mode used in CV. The respondents are faced with a payment card containing a range of payment amounts, and are asked to mark the highest amount they would be willing to pay to get the program or policy in question. Dichotomous choice (DC) or binary question is characterised by a bid offered to the respondent that can be accepted or rejected.

The NOAA panel on contigent valuation [13] recommends the use of the DC format since it is cognitively less demanding, people are used to making dichotomous decisions in markets (to buy a product or not, given a price) and it also has good incentive-compatible properties [14]. Incentive compatibility means that the subject does not have, in principle, any incentive to respond in a strategic way. It is in his or her best interest to reveal preferences honestly. This is not the case for the other response modes. For example, in the bidding game format, subjects may anchor their response in the first amount they are offered (the so-called starting-point bias).

Within the DC format, there are basically two options, namely, single-bound and double-bound formats. In single-bound dichotomous choice (SBDC), only one yes/no question is asked to the subject, and in double-bound dichotomous choice (DBDC), the respondent is asked a second yes/no question depending on the previous answer. DBDC does not have the same good incentive-compatible properties as SBDC. For example, if a subject says yes to the first question and is asked a second question with a higher bid, this second bid may come as an unpleasant surprise, and the subject may suspect that there will be yet higher bids coming if he or she accepts again, so there may be some incentive to say no to the second bid for strategic reasons. In fact, it is a common finding in the literature that the DBDC produces lower estimates than SBDC [15], and this can be explained by the arguments just given.

However, although DBDC can be subject to some biases it provides more information than SBDC. This has been called the ''bias versus efficiency trade-off'' [16]. SBDC is less biased, but it is less efficient. Also, it has been shown that the DBDC can help to avoid problems of a bad choice for the first bid [17]. In this paper we use both SBDC and DBDC.

DC has many advantages, as we have shown, but also has problems. The main disadvantage of the DC format is that each respondent provides less information about his or her preferences than in other formats. A CV survey typically has several versions, where each version uses a different set of bids for the WTP questions. The set of bids is distributed randomly across the sample. For this reason, it usually requires a larger sample and extensive pretesting. This preliminary work is very important since the bids have to be distributed in such a way that they allow the researcher to get a good idea of the distribution of WTP preferences. It is very important to pick up the centre and the extremes of the WTP distribution to be able to estimate

central measures of tendency and also variability around these measures [18].

Focus groups and pilot survey

The survey was first piloted using administrative staff of the university as subjects. Once the first draft was modified, three focus groups were held with a total of 17 participants. These focus groups were very useful to show that:

1. People were familiar with the potentially fatal consequences of MI but did not have a basic understanding of the nature of this problem. In order to overcome this limitation, the first part of the questionnaire explained to subjects some issues about the nature and consequences of an MI.
2. We had to insist that, if the MI was severe, the risk of death was higher after the patient overcame the acute phase than for people with similar characteristics (same age and gender) who had not suffered an MI. We had to insist that an effective medicine reduces the risk of death but, even in this case, the risk of death after a severe MI remains higher than before the MI. In this way, the need for long-term medication was justified.
3. We had to use visual aids to illustrate the concept of risk.
4. People understood the risk better if it was explained as a frequency rather than as a probability.

After focus groups were heldm we conducted 50 interviews with the OE question. These interviews had two objectives. The first was to pilot the questionnaire again in a larger group. The second was to get information about the shape of the WTP distribution. We wanted to know the bids that were approximately in the 15th, 35th, 50th, 65th and 85th percentiles of the distribution. In this way we would have information about the centre and about the dispersion. However, as there is evidence that people respond to binary questions in a different way from OE questions, we conducted another pilot survey with 120 subjects using the DC format. The bids we used were obtained from the information that we got from the OE survey. In fact, we checked that the percentage of affirmative responses in the DC survey was higher than predicted by the results of the OE questionnaire. We then introduced some changes in the bid design.

After all this piloting, we thought we had enough information about the bid distribution in order to conduct the final survey. The final bids were €30, €60, €90, €120 and €240 (payments per month) for the ex-post case and €6, €18, €30, €60 and €90 (per year) in the ex-ante framework. All these interviews were also very useful for checking potential problems in the framing of the questions.

The bids were distributed in five different random subsamples. The first and second bids of each group can be seen in Tables 1 and 2.

Final survey

The final survey consisted of five parts. In the first part, we gave information to the subjects about what an MI was and its consequences. The key points that we emphasized were (1) after a severe MI the risk of death is higher than the risk for other people with the same characteristics, and (2) the effect of the medicine was to reduce the risk but not to return the patient to the same risk as before the MI.

In the second part, subjects were asked about their WTP for the medicine in a DBDC ex-post frame. They were asked to assume that they had had an MI. We told them that the first year after the MI their risk of death was 16%, but, if they took the medicine, the risk of death would be reduced to 14% the first year after the MI. We told them that although the benefits (reduction in the risk of death) would also continue after the first year, it was the first year after the MI that most deaths would be prevented if they took the medicine. The question was then asked whether they would (or not) be willing to pay a certain amount (the bid) monthly for 5 years. Although the duration of the treatment is an issue that has not been settled, some experts told us that this was a reasonable assumption.

In the third part, the ex-ante framing was explained. They were informed about their risk of having an MI next year and throughout their lives. They were told the probability of needing the medicine in the future. They were

Table 1 Bid structure (€) for the ex-post case (n = 70 per group)

Group	B	B^u	B^d
I	30	60	15
II	60	90	30
III	90	120	60
IV	120	240	90
V	240	300	120

B Bid, B^u follow-up upper bid, B^d follow-up lower bid

Table 2 Bid structure (€) for the ex-ante case (n = 70 per group)

Group	B	B^u	B^d
I	6	18	1
II	18	30	6
III	30	60	18
IV	60	90	30
V	90	120	60

B Bid, B^u follow-up upper bid, B^d follow-up lower bid

asked if they would vote in favor of a proposal to increase taxes by a certain amount next year in order to have access to this medicine if they had an MI.

In the fourth part, we asked some attitudinal questions such as whether they thought that the medicine would have side effects or if they thought that the probability they would really need the medicine in the future was very low, low, equal, high or very high. Finally, sociodemographic questions were asked.

Consistency checks

Estimates should be consistent with some theoretical principles. Three kinds of consistency checks were performed. First, we observed if there was a positive correlation between WTP and income, since theory suggests that there has to be a positive correlation. Second, the percentage of people willing to pay a certain bid has to decrease as the bid increases. Third, WTP has to be larger when responses are elicited in an ex-ante context. The reason is that in this case people not only pay according to the benefit that the medicine produces at the point of consumption, but also for the option value, that is, for the certainty that the medicine will be available in case they need it. This is the usual case when people pay to insure a good. The total amount that people pay in order to assure a good is higher than the value of the good itself.

In order to compare ex-ante and ex-post WTP we will estimate WTP per patient according to each framework. The ex-post frame responds directly to this question, since this is the question (WTP per patient) that people are asked under this framing. The ex-ante frame requires estimating the total amount of money that a group of taxpayers would pay and the number of people who would need the medicine in this group. Dividing these two amounts we estimate WTP per patient. For example, if 100 potential patients pay 100€ per year and one of them is going to need the medicine each year, the WTP per patient would be 10,000€.

Statistical methods

For the analyses reported in this study, we use DBDC and SBDC formats to provide an assessment of the value of eplerenone through estimates of mean WTP, as is common practice [18].

The SBDC format only considered the first yes/no responses. The probability of obtaining a yes response in the SBDC model can be represented by:

$$\pi^{y} = \text{Prob(yes)} = \text{Prob(WTP} \geqslant \text{BID)} \tag{1}$$

and the probability of eliciting a no response is $(1 - \pi^{y})$.

In this analysis, we use the logit model, so that π^{y} takes the following form:

$$\pi^{y}(\text{BID}) = G(\text{BID}, \theta) = \left(1 + e^{[\alpha - \beta(\text{BID})]}\right)^{-1} \tag{2}$$

where $\theta \equiv (\alpha, \beta)$, α and β are the estimated coefficients and BID is the certain amount asked to pay. Additional coefficients such as, for example, attitudes or sociodemographic information about the respondents may be included in the model.

The most commonly used technique for estimating the logit model is the maximum likelihood (ML) estimation [19]. The log-likelihood function following Hanemann et al. [17] is:

$$\ln L^{5}(\theta) = \sum_{i=1}^{N} \left\{ d_i^{y} \ln \pi^{y}(\text{BID}_i) + d_i^{n} \ln \left[1 - \pi^{y}(\text{BID}_i)\right] \right\} \tag{3}$$

where d_i^{y} is 1 if the ith response is yes to the bid offer and 0 otherwise, while d_i^{n} is 1 if the ith response is no and 0 otherwise.

The mathematics of the DBDC format are a straightforward extension of the SBDC format [20]. In DBDC format, each respondent is faced with two sequential bids. The level of the second bid is contingent upon the response to the first bid. Therefore, there are four possible outcomes: (1) both answers are yes, (2) both answers are no, (3) a yes is followed by a no, and (4) a no is followed by a yes. The probabilities of these outcomes are π^{yy}, π^{nn}, π^{yn}, and π^{ny}, respectively [17].

If d_i is a binary indicator variable for the yes or no responses to the two bid offers, then the log-likelihood function for the double-bounded model, parameterised by θ is:

$$\begin{aligned} \ln L^{D}(\theta) = \sum_{i=1}^{N} \{ & d_i^{yy} \ln \pi^{yy}\left(\text{BID}_i, B_i^{u}\right) \\ & + d_i^{nn} \ln \pi^{nn}\left(\text{BID}_i, B_i^{d}\right) + d_i^{yn} \ln \pi^{yn}\left(\text{BID}_i, B_i^{u}\right) \\ & + d_i^{ny} \ln \pi^{ny}\left(\text{BID}_i, B_i^{d}\right) \} \end{aligned} \tag{4}$$

where BID_i represents the starting bid value, B_i^{d} represents the follow-up lower bid value, and B_i^{u} represents the follow-up higher bid value.

Under the assumption of a logistic distribution, the mean and median coincide and may be obtained through $-\alpha/\beta$ where α is the constant and β the bid coefficient, both estimated using the logit model.

The confidence intervals around mean WTP were calculated using the Krinsky and Robb [21] (1986) procedure with 1,000 repetitions.

Table 3 Sociodemographic characteristics (n = 70 per group)

Group	Age (mean)	Gender (% women)	Income (%)			
			Low <€600/month	Middle €601–€1,800/month	High >€1,800/month	Mean (monthly €)
1	45.5	48.6	35.7	55.7	8.6	1,077
2	44.8	50.0	38.6	45.7	15.7	1,097
3	44.7	50.0	32.9	52.9	14.3	1,140
4	46.3	52.9	40.0	50.0	10.0	1,069
5	45.3	51.4	35.7	58.6	5.7	1,056

Table 4 Percentage of affirmative responses to SBDC and DBDC (ex-post case) (n = 70 per group)

Group	B	% Yes to B	B^u	% Yes to B^u	B^d	% Yes to B^d
I	30	89	60	66	15	10
II	60	67	90	34	30	17
III	90	43	120	14	60	29
IV	120	26	240	7	90	26
V	240	10	300	4	120	14

B Bid, B^u follow-up upper bid, B^d follow-up lower bid

Table 5 Percentage of affirmative responses to SBDC and DBDC (ex-ante case) (n = 70 per group)

Group	B	% Yes to B	B^u	% Yes to B^u	B^d	% Yes to B^d
I	6	91	18	70	1	6
II	18	80	30	43	6	11
III	30	73	60	40	18	17
IV	60	40	90	24	30	39
V	90	29	120	10	60	23

B Bid, B^u follow-up upper bid, B^d follow-up lower bid

Data treatment

The regression analysis and the rest of the data processing were undertaken using version 7 of LIMDEP statistical package (Econometric Software, Castle Hill, Australia).

Results

The five groups were comparable in age, gender and income (Table 3). None of the differences among groups were statistically significant ($P < 0.05$). In the case of income, the data were collected using ten categories that we reduced to three. Given the relevance of this variable and the influence that it has in WTP studies, we also converted it into a continuous variable by assuming that income was in the middle of each of the ten categories, and we estimated the mean, which can also be seen in Table 3.

The yes responses for each group can be seen in Tables 4 and 5.

As can be seen in both cases, there is a clear tendency for affirmative responses to decrease as the bid increases, as expected (Tables 4 and 5). In the ex-post part, the percentage of yes responses decreases more smoothly and the bids are more evenly spread than in the ex-ante case. Also, the three amounts in the middle pick up the centre part of the distribution quite well. In the ex-ante scenario, the second bid (€18) is too close to the first and third ones, adding little information about the shape of the WTP distribution function. There is also a sudden drop between bids three (€30) and four (€60), showing that it would have been better to have inserted another bid between these two amounts. However, we think that in both cases we picked up the shape of the WTP distribution fairly well since we have enough information on the central bids and the extremes.

Table 6 Regressions with better fit

Variable	Ex-post		Ex-ante	
	Coefficient (*t*-ratio) SBDC	Coefficient (*t*-ratio) DBDC	Coefficient (*t*-ratio) SBDC	Coefficient (*t*-ratio) DBDC
Constant	3.2036** (4.673)	2.6199** (4.452)	2.1852** (3.258)	2.6265** (4.839)
Bid	–0.02268** (–9.778)	–0.03079** (–19.445)	–0.03768** (–8.381)	–0.0452** (–14.599)
Perceived risk	0.5608** (3.830)	0.3949** (2.986)	0.2432 (1.601)	0.3478** (2.842)
Income	0.1467** (1.981)	0.2546** (4.516)	0.1604** (2.293)	0.1622** (3.028)
Observations	350	350	350	350
Mean WTP (€)[a]	141.2	85.061	58.012	58.04
Confidence interval 95%*	(88.3, 199.4)	(50.1, 121.4)	(24.9, 94.9)	(36.2, 80.5)
% of hits (% predicted correctly)	78	78	76	76
FCCC (%)		51		47

*$P<0.05$, **$P<0.01$

FCCC Fully correctly classified cases

[a] Monthly payment for the certainty case and yearly payment for the uncertainty case

We estimated several models including all the socio-odemographic and attitudinal variables collected in the survey. To save space, only the model with independent variables significant at the 0.05 level was kept. Sociodemographic variables such as gender or age were consistently insignificant and were removed from the final model. The final statistical model includes the bid, income and the perceived risk as independent variables. The latter variable (perceived risk) comes from the question that asked people about the possibility of needing the medicine in the future. They had to respond using a five-point Likert-type scale from ''possibility very low'' to ''possibility very high''. So two subjects that were informed that they had the same objective risk could, in practice, have a different risk perception. The final model was estimated for the ex-ante and ex-post frameworks, according to the SBDC and DBDC models. All models were estimated by maximum likelihood, using the likelihood function in Eq. 3 for the SBDC formats, and that in Eq. 4 for the DBDC formats.

The results of the logistic regression analysis are given in Table 6. All the variables considered in the analysis were found to be determinants of WTP in the four models, except perceived risk in the SBDC model for the ex-ante framework. The perceived risk coefficient remains positive but is not statistically significant at the 95% confidence level.

The signs of the coefficients were as expected. The negative sign of the bid coefficient indicates that the probability of saying yes to a bid decreases as the value of the bid increases. On the other hand, respondents with higher incomes are more likely to accept the bid as denoted by the positive sign in the income coefficient. Finally, the perceived risk coefficient is positive, indicating that respondents with higher perception of needing eplerenone in the future are more likely to agree to pay for medicine. In other words, since eplerenone reduces mortality among patients with acute myocardial infarction, respondents with higher risk perception about suffering a heart attack are willing to pay more for the medicine.

A goodness-of-fit for SBDC formats is the classification procedure, which counts the percentages of ''hits and misses'' obtained when the predicted outcomes are compared to the actual outcomes [22]. Under this procedure, for the SBDC formats, the ex-ante and ex-post frameworks yielded 76 and 78% accurate predictions, respectively (Table 6). To measure the goodness of fit of the DBDC format, we followed the sequential classification procedure proposed by Kanninen and Khawaja [20]. This approach considers the proportion of fully correctly classified cases (FCCC), counting the correctly classified cases with respect to the first question alone and then using only the observations that were correctly classified according to the first question to count the correctly classified cases for the second question (for a discussion on the merits and drawbacks of the sequential classification procedure, see [20]). By using this procedure, for the DBDC formats, the ex-ante and ex-post frameworks yielded FCCC measures of 47 and 51%, respectively. The results of goodness-of-fit calculations are presented in Table 6.

The estimates of the means and their confidence intervals are presented in Table 6 for all models. The confidence intervals around the mean WTP were calculated using the Krinsky and Robb procedure with 1,000 repetitions. The mean WTP in the ex-ante framework is expected to be higher than in the ex-post case. In order to compare the mean WTPs, we assumed, for the ex-ante scenario, a cohort of 100 people with the average age of our sample

(45 years), and that they would all pay €58 per year for the rest of their lives (about 35 years). Note that this amount is the mean WTP obtained in both the SBDC and DBDC formats. The net present value of this is €1,082 (assuming a 4% discount rate). Therefore, the 100 people would pay a total of €108,200. Using the incidence of MI in Spain and assuming that 27% of people with an MI that are discharged alive from hospital will use eplerenone (eplerenone is not indicated for all patients discharged alive after an MI [23]), we estimated the number of subjects who will use eplerenone within their lifetime at 3.6. This amounts to €30,000 per patient (€108,200/3.6). Because in the certainty case we told people that treatment would last about 5 years, the €30,000 per patient implies a monthly WTP of €500 for the treatment. This amount is larger than the €141 and €85 per patient and per month obtained from, respectively, the SBDC and DBDC formats in the ex-post framework, as suggested by theory.

Discussion

This paper has shown how the discrete choice contingent valuation approach can be used to elicit preferences for a medicine that reduces the risk of death. We obtained a different WTP under the SBDC than under the DBDC for the ex-post case. We used two approaches (ex-ante and ex-post) that also produced different results. Whereas the second discrepancy (ex-ante vs. ex-post) can be attributed to theory, the same does not apply to the first discrepancy, SBDC versus DBDC.

The use of DBDC has the main objective of narrowing the confidence interval. This is what happens when we compare the results of the SBDC with the DBDC in both the ex-ante and ex-post case. However, in the ex-post case there is also another difference between SBDC and DBDC, namely, the two means are different and the SBDC provides a higher estimate than the DBDC method. This finding reproduces the tendency that has been found in the literature. This effect can be explained by the presence of a bias in the follow-up question (the second question), as we have explained above. There are two approaches to this problem. One is to try to model the bias and the other is to use the estimates from the SBDC as the most valid since it is a less biased method [16]. We tried the first approach according to a well-known theory [16] but the bias persisted (data not shown). This would have led us to choose €141 as our best estimate under the ex-post framework. Although this is a legitimate approach, we think that there might be other kinds of bias in the contingent valuation method, like the hypothetical bias, that may increase our WTP estimates artificially. For this reason, we will consider €85 as our base case.

The second discrepancy (ex-ante vs. ex-post) does not come as a surprise since theory suggests this should be the case. The reason is that most people are willing to pay more than the expected value of a prospect for insurance coverage of the loss associated with that prospect. However, the theory does not say anything about the magnitude of this difference. In O'Brien et al. [9], the willingness to pay per episode of febrile neutropenia avoided was $33,000 with the user-based (ex-post) approach and €1,200,000 with the insurance-based (ex-ante) approach. That is, in the insurance-based approach, a WTP more than 30 times larger was found. In our approach, WTP per fatality avoided is about six times larger with the insurance-based approach. Although this difference is smaller than in O'Brien et al. [9], it is large enough to merit some degree of concern. One possible explanation for the difference between these two values is the degree of risk aversion. The higher the risk aversion, the more people are willing to pay to buy insurance to insure an object of a constant subjective value. The other possibility is that people have found problems in valuing the two risks that are relevant for this question, that is, the risk of having an MI and the risk reduction if they take eplerenone, leading to a WTP that it is too high. Unfortunately, we cannot infer from the survey which of the above explanations underlies that difference.

It is quite clear that both framings provide different estimates and the question is which of the two should be used in social decision-making. Should the government spend €85 or €500 per month on eplerenone? One way of solving the problem is to apply theory. According to theory, the correct framework is the one that uses taxes [8]. However, from a practical point of view, this framework is much more cognitively demanding since it involves the computation of two probabilities. If people have problems working with probabilities (as it has been shown they have), the tax frame can produce estimates that are less reliable. Johannesson [11] has shown that, under certain conditions, willingness to pay ex-post can be considered as a conservative estimate of ex-ante WTP. That is, if we think that ex-ante WTP is the correct framework, but we consider that it is too cognitively demanding, we can use ex-post WTP as a lower bound for ex-ante WTP. The response to the above question is therefore that there are no clear arguments to choose €85 or €500 as the correct amount, but we can say that €85 is theoretically correct as well as a conservative estimate. The probability that the government will make an inefficient decision if it spends €85 per month on eplerenone is quite low. Also, some authors have argued that WTP estimates can be upward-biased due to the hypothetical nature of the question [24], and this is another argument to use €85 instead of €500 as a conservative estimate of WTP.

However, while accepting that €85 per month is a conservative estimate, we also want to mention that there are reasons to think that this amount is too low and that an amount between €85 and €500 should also be considered. Our argument is that this payment would imply a value of a statistical life that, according to many standards, would be too low. To see this, assume that our subjects pay €85 per month for 5 years. This amounts to about €4,500 in net present value. If 100 of them pay €4,500 and fatalities are reduced by 2% points, there would be two fewer fatalities in the group of 100. As they would have spent €450,000, this would imply a value of a statistical life of about €225,000. The figures that are used in the literature are clearly higher. For example, in Europe, a recent study [25] funded by the European Commission (EC) has estimated at €1,000,000 the value of a fatality prevented, so our conservative estimate of €85 per month may indeed be too conservative.

There is a final question we would like to clarify, and it deals with the relation between cost-effectiveness thresholds and our WTP estimates. There is one cost-effectiveness study of eplerenone [26]. It found that the cost per life-year gained using eplerenone is of about €13,000 gained. In order to judge if this is too high or too low there has to be some external benchmark with which this number can be compared. The advantage of WTP (and CBA) with respect to CEA is that we do not need an external benchmark since the figure we get from the study is the benchmark.

This paper has at least two limitations that can be the subject of further research. One is the study of scope effects [27]. By ''scope effects'' we mean the sensitivity of WTP to the size of the health gain. In order to study scope effects we would have needed at least another similar group where we would have used a different risk reduction. If we had used a smaller risk reduction we would expect to get a lower WTP. The study of scope effects is then a very interesting issue for further research. The second is the role of the payment and benefit duration in the framing of the WTP question. In our framing we only mentioned the short-term effects of eplerenone since the clinical evidence is restricted to the duration of the trial. However, since it is expected that the benefit will last longer, it would be interesting also to provide information on the benefits of eplerenone in subsequent years (and not only of the first year) and see if this would affect WTP. However, at the time of conducting this survey we did not have very clear evidence of this benefit, and we then chose (again) a conservative option. Finally, although we do not consider this, strictly speaking, a limitation, we think that it would also be an interesting research topic to elicit WTP from patients. However, this may run into ethical problems, since this would require informing people about their risk of death and about their life expectancy. The former is much higher than the risk of the general population and the latter is much lower. To provide this information to patients without causing them unnecessary suffering is a real challenge.

In conclusion, this study has shown that it is feasible to use contingent valuation in order to measure the benefits of a medicine that reduces the risk of death after MI. Our results show that this benefit is in a range between €85 and €500. We therefore consider that €85 per month is a conservative estimate of the benefits produced by eplerenone when measured in monetary units.

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